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Growth Response of Dekoko (Pisum sativum var. abyssinicum) to Nitrogen and Phosphorus Fertilizers at Enderta Woreda, Northern Ethiopia

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Abstract
A field experiment was conducted to investigate the influence of different nitrogen and phosphorus fertilizer on dekoko (Pisum sativum var.abyssinicum) growth parameters. The Experiment was conducted in 2013/14 at the experimental field of Mekelle University Endayesus Campus, Northern Ethiopia. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. It comprises four treatments viz. Control (with no fertilizer), 30 kg N ha^{-1}+30 kg P_2O_5 ha^{-1}, 60 kg N ha^{-1}+60 kg P_2O_5 ha^{-1} and 90 kg N ha^{-1}+90 kg P_2O_5 ha^{-1}. Data on growth parameters like: leaf area, number of branches per plant and plant height were measured and collected. Results show that, the effect of N + P_2O_5 on in all the growth parameters of dekoko was significant at 5% Probability level. The highest leaf area index (2.82m^2m^{-2}) among N+P_2O_5 levels, was recorded from 90 Kg/ha N +90 Kg/ha P_2O_5. Similarly highest Plant height (50.83Cm) was found from the treatment combination of 90 Kg/ha N +90 Kg/ha P_2O_5. Maximum number of basal branches (2.73) was obtained from the highest treatment combination.
Keywords: Growth attributes, nitrogen, phosphorus*, Pisum sativum var. abyssinicum*

1. INTRODUCTION
Grain legumes, play a key role in organic cropping systems (Aslam *et al*., 2010). They could provide nitrogen (N) to the system via N_2 fixation and produce grain rich in protein while improving soil N for the succeeding crop (Corre-Hellou & Crozat, 2005). In addition to this, they are good “break” crops to pests (Chemining-wa and Vessey, 2006).

Dekoko (Pisum *sativam var abyssinicum*) is known for its high market price and for its food preference (Yemane and Skjelva˚g, 2002). Farmers and consumers call it as the “Dero-Wot of the poor”. This may be to express for its good taste and high nutritional value. Most often, the dry seeds of Dekoko are decorticated and split (‘split peas’) before boiling. In Ethiopia the annual consumption per person of field pea including dekoko seeds is estimated at 6 -7 kg (Sentayehu, 2009). Yemane and Skjelva˚g (2002) reported that because of its favorable amino acid profile it can be a suitable complementary protein source for a cereal based diet. Moreover, its early maturation can make it an important crop in areas where the growing season is too short for other cool season food legumes (CSFLs) and yield losses caused by terminal droughts are common.

Despite its high nutritional and economic value, Dekoko is the most neglected pulse crop in the research area. Hence, its productivity is low because of lack of improved varieties, low soil fertility, little or no application of fertilizers. Dekoko is usually sown without fertilizer and as a result its yield under farmer’s condition is often below optimal. Supplying the major plant nutrients, N and P, in dekoko fields could improve its productivity. Although response of growth to nitrogen and phosphorus fertilizers on the other legume crop has been studied (Togay et al., 2005 and Fatima et al., 2013). However, there is limited information about the effect of Nitrogen and phosphorus fertilization on dekoko growth parameters.

2. Material and Methods
2.1 Description of the Study Area
The study was carried out in Tigray region, Northern Ethiopia in 2013/14 growing season at Mekelle University Endayesus campus research site which is geographically located between 13 ^{0}28'47"N latitude and 39^{0}29'10"E longitudes with an altitude of 2225 m.a.s.l. The dominant soil type of the experimental site was a Cambisol (Habtegebrial and Singh, 2006) with a sandy clay loam texture up to 0.45cm in depth. Soil depth is approximately 1m with white calcareous rocks beneath the soil. Rainfall distribution of the study area is largely mono-modal that spreads from June to first week of September. The long term rainfall data of the study area (1993 -2013) indicated that annual average rain fall amount was 543.2 mm with the highest rainfall observed in July and August. The average temperature of the study area was also 18.87^{o}C with a mean maximum temperature of 26.22^{o}C and mean minimum temperature of 11.52^{o}C respectively (Figure 1).

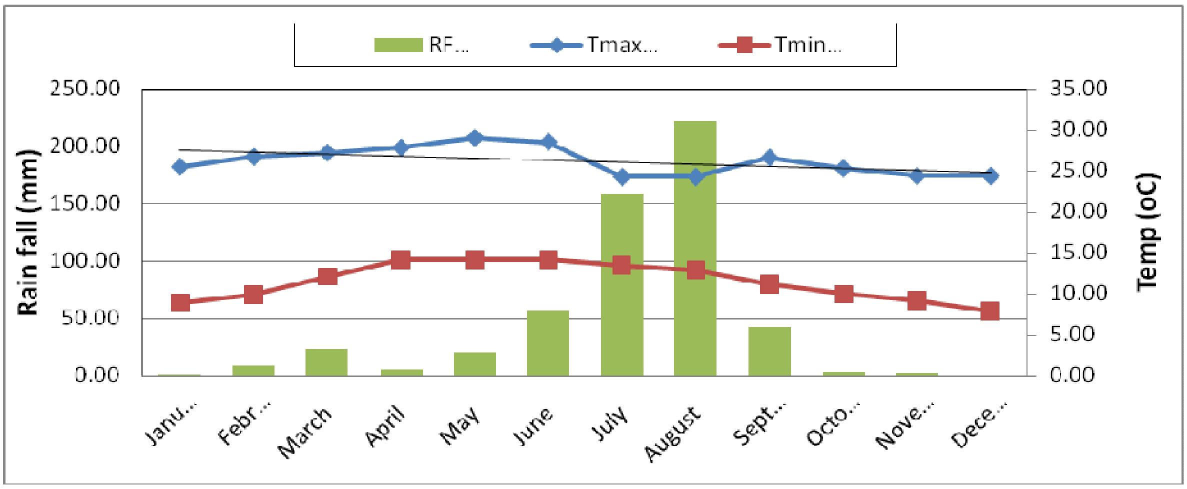

Figure 1: Monthly mean rainfall, mean minimum and maximum temperature during the period1993 - 2013 for the study area

2.2 Experimental design and procedures

The experiment involved four treatment combinations(0 kg N ha^{-1} + 0 kg P_2O_5 ha^{-1}; 30 kg N ha^{1} + 30 kg P_2O_5 ha^{-1} ; 60 kg N ha^{-1} + 60 kg P_2O_5 ha^{-1}; 90 kg N ha^{-1} + 90 kg P_2O_5 ha^{-1}) laid out in randomized complete block design (RCBD) and replicated four(4) times. Each treatment was randomly assigned and sown in a plot area of 4 m by 4m with 1m between plots and 1.5 m between blocks having inter and intra row spacing of 20 cm and 5 cm, between rows and plants respectively. Fertilizer Sources for Phosphorus and Nitrogen were DAP in form of Diammonium phosphate (18% - 46% - 0%) and Urea (46%N) respectively. DAP was incorporated into the soil at sowing and Urea was applied at 100% crop emergence.

2.3 Soil Sampling Procedure and Soil Physico-Chemical Determination

Before sowing, initial soil sample was taken from the experimental field. Ten sub samples were collected randomly from 0 - 30 cm depth by driving a soil auger into the soil. Sub Samples were mixed to get one kg of composite sample. One composite soil sample was then prepared from the ten sub samples. Soil samples were sent to Mekelle soil laboratory research center for analysis of the most important parameters that affect soil fertility and hence crop productivity. Soil sample were air dried, ground, sieved to pass 2 mm sieve for laboratory analysis to determine initial nutrient status. The parameters determined were: soil texture, available phosphorus, total nitrogen, organic carbon (OC), organic matter (OM), Cation exchange capacity (CEC) and pH following standard procedure. A determination of particle size (texture) was done following the Bouyoucos hydrometer (Day, 1965). A hydrometer was used to measure the density of the suspension of soil and water at various times. The PH of the soils was measured in a suspension of 1:2.5 soil water ratio (soil: liquid) by using PH meter (Peach, 1965). The Walkley and Black (1934) wet digestion method was used to determine soil carbon content and percent soil OM was obtained by multiplying percent soil OC by a factor of 1.724. Total Nitrogen was analyzed using the Kjeldahl digestion method as described by Black (1965), by oxidizing the OM in sulfuric acid solution (0.1N H2SO4). Available soil phosphorus was analyzed on the basis of Olsen et al., 1954 extraction method. Cation exchange capacity was estimated by ammonium acetate method (CH_3OONH_4) (Chapman, 1965).

2.4 Phenology and Growth Data Collection

- ✓ **Days to 50 % emergence** : Was recorded when 50% of the seeds emerged above ground
- ✓ **Leaf area index and plant population:** Leaf area and plant population were taken at the beginning of flowering from randomly selected 1m^2 rows by randomly selecting 5 plants from each plot (leaving two rows of plants as border). The leaves were measured using CI-202L portable laser leaf area meter and counting for plant population were carried out from the randomly selected rows. **Leaf Area index (LAI)** was calculated as:

$$\frac{Plant\ Population\ X\ Leaf\ Area\ per\ Plant}{Area\ of\ sampled\ size}$$

- ➢ **Days to 50% flowering (DF):** The number of days from sowing to which 50% of the population in each plot become flowered
- ➢ **Days to 50% maturity (DM):** The number of days from sowing to when 50% of the plants in each plot

had fully matured.

- **Plant height at maturity (PH) (cm)**: This growth parameter was measured from five randomly selected and tagged plants from the harvestable rows of each plot with the help of meter tape from ground surface to the top of the plant.
- **Number of basal branches per plant (NBBP)**: Basal branches producing productive pods were recorded for randomly selected plants and their average was taken.

2.5 Data Analysis

Prior to analysis of the data, plots of the distribution of the residuals, a normal and half-normal plots and a plot of the residuals against the fitted values were produced to assess whether the normality assumptions of the data was violated. All the parameters measured were statistically analyzed using the PROC ANOVA function of statistical analysis system (SAS Institute, 2002). The least significance difference (LSD at a probability level of 5%) test was used to separate the treatment mean value after treatment effect was found significant at $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Soil Physical and Chemical Properties of the Study Area in 2013/14

The analytical results of the initial soil fertility status are presented in Table 1. The soil of the study area was high sand proportion (53 %) followed by silt (27 %) and clay (20 %). Hence according to the soil survey staff (2003), the textural class of the experimental site was sandy clay loam. According to London (1991), if available P is < 5 mg kg^{-1} it is regarded as low, 5- 15 mg kg^{-1} as medium and > 15 mg kg^{-1} as high. Thus, the available P of the soil samples of the study area was about 2.75 mg kg^{-1} that indicates for the low available P. Based on the rating described by London (1991), the soil of the study area was quantified for low N % as the average values were ranged from 0.1 to 0.2%.

Generally the soil of the experimental area was characterized as having low availability of nitrogen and phosphorus, much lower than the appropriate amount required for satisfactory crop production. Moreover, based on Defoer et *al.* (2000), the soil of the study area found deficient in SOM (1.27). The CEC values were ≤ 19.73 $Cmol_ckg^{-1}$ (Table 1) and classified as medium (London, 1991). With regard to the soil reaction (PH) the soil of the study area was found to be neutral (6.94). Foth and Ellis (1997) confirmed that the optimal soil pH for the growth of different crops is in the range of 6.6-7.3. Consequently the soil can be rated as ideal for crop growth and nutrient availability.

Table 1. Soil physico-chemical analysis results of the initial soil fertility of the experimental site.

Soil property		
Texture	Unit	Values
Sand	%	53.00
Silt	%	27.00
Clay	%	20.00
Textural class	-	Sandy clay loam
Av. P	mg kg^{-1}	2.75
TN	%	0.10
OC	%	0.73
OM	%	1.27
CEC	$cmol_ckg^{-1}$	19.73
PH	-	6.94

Av.p: available phosphorus; TN: Total nitrogen; OC: Organic carbon; OM: Organic matter; CEC: Cation exchange capacity

3.2 Effect of Nitrogen (N) and Phosphorus(P) Fertilizers on Dekoko Phenology

The result on 50% emergence showed that there was a non significant and inconsistent difference among different levels of applied N and P fertilizers (p>0.05) (Table 2). The result confirmed that neither high nor low application of nitrogen and phosphorus fertilizers had any significant effect on the germination percentage of dekoko seeds. These results are in line with the finding of ahmed (2001) who reported number of plants per unit area at 50% days to emergence did not differ significantly in case of different level of phosphorus. Also Ali et al. (2001) and Gul et al. (2006) reported a non significant association between nitrogen fertilizers and germination of pea seeds.

The result of variance analysis on 50 % flowering exhibited a significant difference among treatments of NP fertilizer treatments compared to the control at (P <0.05) (Table 2). The plants received the highest fertilizer level, T4 (90 kg N ha^{-1} + 90 kg P_2O_5 ha^{-1}) took longer days to 50% flowering (41 days) as compared to the control where it showed relatively early flowering was observed on the control treatment (40.25 days). However, as N level increased from 0 to 90 kg N ha^{-1}, the days to 50% flowering was delayed. These results are

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in accordance with the finding of Achakzai (2012) who revealed increasing N fertilizer level promoted greater vegetative development for a longer period of time before reproductive phase begins and hence, might have caused delayed in flowering.

Results presented in Table 2 revealed that there was a non-significant variation among various levels of added N+ P_2O_5; however, the clear and significant variation was between the high level of N and P_2O_5 and the untreated control. Days to maturity followed the same trend as that of the days to flowering; as the N + P_2O_5 rate increases maturity tend to delay (Table 2).

Days to maturity followed the same trend like the days to flowering by the application of various levels of N and P_2O_5 (Table 2). This might be attributed to the specifically higher levels of nitrogen fertilizer application which increases the vegetative growth of crops and hence delayed maturity. Rahim et al. (2008) observed that a significant variations in days to 50 % maturity by the application of various levels of nitrogen fertilizers in mung bean. Similarly Khan et al. (2008) reported that crop maturity delayed by application of N fertilizer.

Table 2. Phenology of dekoko (*Pisum sativum var.abyssinicum*) as affected by Nitrogen and Phosphorus fertilizer application.

N and p fertilizer level	Days to 50%		
(Kg ha^{-1})	Emergence	Flowering	Maturity
0 (Control)	6.50	40.25^{b}	65.5^{b}
30 N+30 P_2O_5	6.75	40.75^{ab}	65.75^{ab}
60 N+60 P_2O_5	6.25	40.75^{ab}	65.5^{ab}
90 N+90 P_2O_5	6.50	41.00 ^{a}	66.75^{a}
CV (%)	7.25	1.024	1.22
LSD (5%)	0.75(NS)	0.67	1.12

* Means with different letters in each column are statistically significant at a = 5% (LSD).

3.3 Effect of N and P Fertilizers on Dekoko (Pisum sativum var.abyssinicum) Growth Parameters

Leaf area determines the amount of solar radiation intercepted and consequently the amount of dry matter produced (Jacob and Lawlor, 1991).The analysis of variance result indicated that there is an increment of LAI with the application of NP fertilizers .The increase in LAI was closely related to the number of branches, which increase the total number of leaves. Also it could be in an increase in leaf expansion (Yemane and skjeelvac, 2003). Similar results were reported by (Yahiya et al., 1995).

The analysis of variance revealed that plant height was significantly affected by varying nitrogen and phosphorus fertilizer level at ($P < 0.05$) (Table 3). The highest plant height (50.83cm) was observed at the maximum level of NP_2O_5 fertilizer application (90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1}) followed by 60 kg N ha^{-1} + 60 Kg P_2O_5 ha^{-1} (48.98cm). However, plant height did not vary significantly between the average values of these treatments (60 kg N ha^{-1}+ 60 Kg P_2O_5 ha^{-1} and 90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1}).

The linear trend between plant height and fertilizer rate observed in this study may further proved that nitrogen is the essential component for growth of the crop. Nevertheless, application of NP beyond 60 kg N ha^{-1}+ 60 kg P_2O_5 ha^{-1} has limited increment. The minimum plant height (40.50cm) was recorded from the control plot where no fertilizer was applied. In line with this work, increase in plant height with increase in N fertilizer rate was reported in chickpea (Qureshi et al., 2004; Namvar et al., 2011) and lentil (Togay et al., 2005).

Table 3.Growth parameters of dekoko (*Pisum sativam var. abyssinicum)* as influenced by Nitrogen and Phosphorus fertilizer levels.

N + P_2O_5 (Kg ha^{-1})	LAI(m^2m^{-2})	PHT (Cm)	NBBP
0(Control)	1.04c	40.50^{b}	1.68^{b}
30 + 30	1.84bc	41.44^{b}	1.93^{b}
60 + 60	2.13ab	48.98^{a}	2.63^{a}
90 + 90	2.82a	50.83^{a}	2.73^{a}
CV (%)	9.4	6.79	13.84
LSD (5%)	0.68	4.93	0.48

Where: LAI= Leaf area index, PHT= plant height, NBBP= number of basal branches per plant

Number of basal branches per plant was significantly increased as the NP level increases and the treatment means were significantly different ($P < 0.05$) from the control except treatment T2 (30 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1}) (Table 3). Increasing of N and P fertilizer from 0 to 90 kg ha^{-1} +90kg P ha^{-1}) enhanced the number of basal branches per plant in a linear fashion. Number of basal branches per plant revealed a similar trend as that of the plant height. A similar result was observed in field pea where increases in NP level tend to increase basal branches per plant (Kakar et al., 2002) and (EL- Desuki et al., 2010).

4. Conclusion

This study was conducted to evaluate the response of dekoko *(Pisum Sativum Var. abyssinicum)* Growth Parameters to different nitrogen and phosphorus fertilizers in Mekelle university Endayesus campus. From the field experiment result, Growth attributes such as plant height, leaf area and number of branches was significantly affected by the application of Nitrogen and phosphorus fertilizers. Largest plant height, LAI, Number of branches per plant were resulted from the application of high rate of N and P_2O_5 fertilizer (90 Kg N and 90Kg P_2O_5). Hence, this study recommends that farmers should apply N and P_2O_5 fertilizers to improve growth and productivity of dekoko at the low N and P_2O_5 soils.

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